Moreover Matthews,[4] 1902, states that protoplasm consists essentially of a colloidal solution, and stimulation is accompanied by the passing of this solution to or toward a gel; and with these statements I am in accord. Matthews, however, believed the anions to be the stimulating ions, and he also thought the colloidal particles carried a positive charge. Later studies by many observers have made it apparent that the cations are the active agents in most physiological processes, and that living protoplasm is normally alkaline and thus its colloids probably carry negative charges. Moreover the phenomena of adsorption were not well understood in 1902 and Matthews makes no mention of it in respect to nerve conduction.

No one indeed had reason to support the view that adsorption plays a part in nerve conduction until the determination of the change in rate of nerve conduction of *Cassiopea* in successive dilutions of sea-water suggested this as a possibility.

My results lend no support to the theory of Sutherland[5] that the velocity of propagation of nerve impulse is that of a shear in the substance of the nerve. If this were the case its rate would vary with the viscosity of the surrounding fluid, but the decline in rate is practically the same whether the sea-water be diluted with distilled water, 0.9 molecular dextrose, or 0.4 molecular magnesium chloride.

[1] Hardy, W. B., *J. Physiol., Cambridge*, **24**, 296 (1899).

[2] Bayliss, W. M., *Biochem. J.*, **1**, 177 (1906), finds that electrolytes when adsorbed are non-ionized and no longer take part in the electrical conductivity of the solution. See also: *Principles of General Physiology*, p. 54–71 (1915).

[3] Loeb, J., 1899, *Festschrift für Fick*, and *Amer. J. Physiol.*, **3**, 327–338 (1900).

[4] Matthews, A. P., *Science*, **15**, 496 (1902).

[5] Sutherland, W., *Amer. J. Physiol.*, **14**, 112 (1905), and *Ibid.*, **23**, 115 (1908).

ZUÑI CULTURE SEQUENCES

By A. L. Kroeber

MUSEUM OF THE AFFILIATED COLLEGES, SAN FRANCISCO

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The vicinity of the famous Indian pueblo of Zuñi in New Mexico has long been known to be rich in ruins. Many of these have been reported and described, some surveyed, and material from various sites has found its way into collections. A large body of specimens was secured through excavations by the Hemenway expedition, but this material and its data remain unpublished.

The region furnishes an unusual opportunity for an attack on the chronology, or at least the sequences of culture, in the prehistory of the

Southwest: first, because the restricted area excludes differences due to varying environments, and thus renders any observable distinctions directly interpretable in terms of time: second, because of numerous links between the historic and prehistoric periods. Several of the ruins were inhabited in Spanish times. They still bear native names that tally with those mentioned in sixteenth and seventeenth century records and some contain ruins of abandoned Catholic churches.

The tempting opportunity thus offered must of course be followed with the spade for ultimate results. I was in Zuñi during the summer of 1915. Pressure of ethnological work forbade digging; but some three thousand potsherds were gathered from the surface of about fifteen once inhabited sites within a few miles' radius of the pueblo. These were supplemented by a thousand fragments from the streets and roofs of Zuñi itself.

It was obvious that the pottery was of two well marked types, and that the surface of any one ruin yielded only such ware as plainly belonged to one or the other of the two classes. One set of sites is littered with sherds of which at least half are dull black or dark gray. The other half are as frequently red as white. Three-colored pieces—black and red on a white ground—are found. Corrugated ware is uncommon and about evenly distributed between dark and light.

On the second set of sites, black and red ware are both rare, white or whitish pieces constituting more than nine-tenths of the total. Three-color pottery has not been found. Corrugated sherds are common, but almost always of the light variety.

The first group of sites includes those which are mentioned as inhabited villages in the seventeenth century. Their sherds occur in nearly the same proportion as in modern Zuñi. These ruins therefore fall in part into the historic period. The second group of sites is wholly prehistoric. Their ware resembles that familiar as Cliff Dwellers' pottery. The two wares have been designated as type A, the later, and type B, the earlier.

The conditions of the ruins accords with this arrangement in time. Type A ruins normally include standing walls, and loose rock abounds. All type B sites are low or flat, without walls or rock, and show only pebbles in the surface soil. It seems more likely that this condition is due to the decay of age, or to the carrying away of the broken rock to serve as material in the nearby constructions of later ages, than to any habit of the period B people to build in clay instead of masonry. The latter possibility can be seriously entertained only if excavation reveals no building stone whatever in type B ruins.

Chips of obsidian are usually observable on period A sites, but have not been found on those of period B.

The proportions of different wares can be summarized thus:

	Eight Sites of Period A.	*Nine Sites of Period B.*
Wholly black	53	5
White or black on white	25	92
Containing any red	22	3
	100	100

Differences between sites of the same period can also be observed. These indicate minor periods of time. Expressed in percentages of the total number of sherds secured at each spot, the frequency of several wares is:

Period	*Site*	*Corrugated*	*Three Color*	*Black on Red*	*Any Red*	*Black*
Present	Zuñi	0[1]	12	1		
Late A	Towwayallanna	1	8	3	22	53
	Kolliwa	—	7	2		
	Shunntekya	2	7	2		
	Wimmayawa	2	4	1		
	Mattsakya	3	4	3		
	Kyakkima	4	3	2		
Early A	Pinnawa	10	1	8		
	Site W	24	—	1		
Late B	Hattsinawa	27	—	5	10	19
	Kyakkima West	12[2]	—	4	8	—[2]
Middle B	Shoptluwwayala	40	—	2	3	7
	Hawwikku B	49	—	6	12	9
Early B	Te'allatashshhanna	66	—	—	—	5
	Site X	71	—	—	3	1
	Tetlnatluwwayala	72	—	—	2	—
Uncertain	He'itli'annanna	—	—	—	—	3
	Site Y	—	—	—	—	—

[1] Present, but less than half of 1 %.

[2] Only 25 pieces altogether are available from this site.

The material as yet at hand is too slight, and too superficial in provenience, to make this classification into sub-periods more than tentative for any particular site. The statistics however do allow of three conclusions. First, the two principal periods are almost certainly subdivisible into shorter epochs. Second, these subdivisions shade into one another. Third, there is no gap or marked break between periods A and B. So far as Zuñi valley is concerned, the prehistory of Southwestern native civilization has therefore been in the main a continuous development from the earliest known time to the present.

A. V. Kidder's recent 'Pottery of the Pajarito Plateau,' in volume 2 of the *Memoirs of the American Anthropological Association*, presents analogous results, obtained by a method differing in some details, for another

region of New Mexico; and at San Cristobal in still another part of the state, N. C. Nelson has excavated a stratified deposit showing four successive layers of different type. It is quite likely that some of the types at these three sites will prove to be similar, or even identical, as soon as the material can be compared. In this event a chronological frame work would be established that may prove capable of extension to accommodate a considerable part of the prehistoric data from the Southwest, and to fix distinctive and otherwise undatable local variations of ancient culture. The impression that there were at least two principal periods in the Southwest, the earlier represented by what are currently called Cliff Dweller forms, has of course long been prevalent, but the supporting evidence has been random. The three present sequential determinations promise not only definitely to establish but to elaborate the older general conviction.

The findings here discussed will be published in the Anthropological Papers of the American Museum of Natural History.

THE NUMERICAL RESULTS OF DIVERSE SYSTEMS OF BREEDING

By H. S. Jennings

ZOOLOGICAL LABORATORY, JOHNS HOPKINS UNIVERSITY

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When organisms differing with respect to a pair of characters are bred for generation after generation, the relative numbers of individuals that will show any particular combination of characters in any given generation of course depend on the system of mating followed. The different classes of individuals may mate at random; or there may be assortative mating (dominants with dominants, recessives with recessives); or dominants alone may be bred; or recessives alone. Or again, self fertilization may prevail; or one of the various possible types of inbreeding may be followed. If we represent the two alternative characters by A (dominant) and a (recessive), then three types of individuals are possible, AA, Aa, and aa. The question here raised is as to the relative numbers of each of these three types of individuals after any number n of generations of mating, by any of the systems mentioned above. This depends of course on the constitution of the parents at the beginning, as well as on the system of breeding and the number of generations.

When breeding by a given system is continued for many generations, several types of results may be distinguished:

A. In some cases the proportions of the population having particular